San Francisco Bay Conservation and Development Commission
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May 15, 2015

TO: All Engineering Criteria Review Board Members

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SUBJECT: **Treasure Island Redevelopment Project (Second Review Meeting)**
(For Board consideration on May 28, 2015)

Project Summary

Project Name. Treasure Island Redevelopment Project

Co-Applicants. The Treasure Island Development Authority ("TIDA"), City and County of San Francisco, Treasure Island Community Development ("TICD"), LLC.

Project Representatives. Robert Beck (TIDA), Kheay Loke (TICD)

Presenters. Robert Beck, Kheay Loke, Dilip Trivedi, P.E. and Brad Porter, P.E. (Moffatt & Nichol), Uri Eliahu, G.E. (ENGEO).

Project Background. Treasure Island (TI) and Yerba Buena Island (YBI) are in San Francisco Bay, approximately midway between the downtown San Francisco and West Oakland. The Islands are the site of the former Naval Station Treasure Island ("NSTI"), which is owned by the U.S. Navy. NSTI was closed on September 30, 1997, as part of the Base Realignment and Closure Program.

TIDA is proposing to redevelop the portions of NSTI still owned by the Navy. The Development Plan will be carried out by TICD.

The ECRB reviewed the project on January 22, 2015. As a follow-up to that Board review, the staff requests further technical advice regarding the project's engineering criteria.

Project Phases. Since the January Board meeting that generated the criteria review comments, the project proponents have developed recent draft geotechnical and marine structural design documentation in relation to Subphase 1A. This area has now been divided in to Subphases 1B, 1C and 1E of the south western region of the TI project.

Summary of Contingency Provisions. At its January 22, 2015 review, the ECRB raised several questions that could not be resolved at the meeting. Therefore, the Board made a motion that the engineering criteria be reviewed at a later design stage, that the criteria reviewed for approval only pertained to Subphase 1A (now-named subphases 1B, 1C and 1E) of the south western boundaries of the project area, and that the project move forward with several contingency provisions as described below.

Prior Board Comments and Applicants' Response. The ECRB's prior Board comments are provided below. The applicants responded to the Board comments on March 12, March 25 and April 29, 2015. Abbreviated applicants' responses (AR 1, AR2, etc.) are summarized below and are shown in *italics*. More complete responses are provided in the attached *Technical Memorandum No. 3*, dated May 13, 2015.

1. The Board requested that the Subphase 1A project return to the Board for further review at a more complete design stage.

   AR 1: The applicants are prepared to adequately address and respond to the subject comments at the May 28, 2015 Board review.

2. The Board requested site specific response spectra at the locations of each of the major project in Subphase 1A, including the ferry terminal building, the ferry terminal breakwater structures, the DSM barrier, and the Causeway. Each site specific estimate is to be based on detailed shear-wave velocity profiles, as inferred from boreholes and geologic cross sections from the surface to bedrock and corresponding soil response models most appropriate for each location, consistent with definitions of Site Class F site-specific procedures provided in ASCE 7-10 and CBC 2013. Additional justification is requested for any sites underlain by water saturated sand layers near the surface, not classified as Site Class F.

   AR 2: "The applicant concurred that according to ASCE 7-10 and CBC 2013, the project site is a Site Class F and that the anticipated site response will likely result in increased spectral accelerations at longer periods. However, for the short period shoreline stabilization structures, founded below the liquefiable and soft deposits, we believe it is conservative to assume a Site E for the purposes of estimating the peak ground acceleration. Long-period structures will require development of site specific response spectra and we anticipate performing those analyses during final structural design."

   BR 2 (a): The ECRB recommendation requested estimates of site-specific response spectra at the location of major components of the SubPhase 1 project because, as the applicants concurs, the sites are classified as Site Class F, hence ASCE 7-10 and CBC 2013 procedures require that site-specific procedures be applied to develop site-specific response spectra. To the Board's knowledge, no code procedures have been adopted to provide Site Class E ground motions as a substitute for Site Class F sites, regardless of period range. Hence, the ECRB requested estimates of site-specific response spectra.

   AR 2 (a): The applicant states, "TICD completed $83,000 of additional off-shore CPT's a few weeks ago in order to respond to this request (it took time to contract and mobilize a drilling platform). ENGEO needs time to analyze the results…." The applicants will present the analysis to the ECRB's May 28th review.

3. The Board recommended that a thorough analysis be conducted regarding the impact of earthquake induced liquefaction and lateral failures on loads and deflections of guide piles, gangway, and potential rock dike movements near the ferry terminal.

   AR 3: "The applicant performed general limited equilibrium (GLE) analyses outboard of the ferry terminal to check for lateral flow after the MCE event. This check was done using post-liquefied residual strengths and without a seismic load. If the factor of safety of the GLE analysis is less than 1.0, the system is deemed unstable and flow will likely occur. Since the rock dikes at the perimeter of the island are founded on either liquefiable shoals or fills, the analysis shows a factor of safety of less than 1.0. Based on this we believe that the outboard side of the shoreline at the ferry terminal will slump and displace horizontally. In order to assess the horizontal permanent displacements at the ferry terminal due to the slumping of the rock dike we used qualitative geometric interpretations of the post-earthquake movements (Figures 2-1 and 2-2) as well as Plaxis results from similar areas of the shoreline (Figure T3-15). Based on these two approaches we believe that the rock dike may horizontally displace up to 10 feet towards the bay. In addition, we performed simplified deformation analysis within the soft young deposits outboard of the ferry terminal to determine additional horizontal deformations. We estimated a potential of 3 feet of horizontal deformation of the soft bay deposits outboard of the island (Figure 4). In summary, all piles driven within 10 feet of the toe of the rock dike will be subjected to kinematic loads from the rock dike, and all piles driven in the young bay deposits within the limits shown in Figure 4, will be subject to kinematic loads from the young bay deposits."

   BR3 (a): The Board recommended that a thorough analysis be conducted regarding the impact of earthquake induced liquefaction and lateral failures on loads and deflections of guide piles, gangway, and potential rock dike movements near the Ferry Terminal.

   AR (a): "Refer to previous answer in attached "150312_" email and highlighted Item 11. Also look at the previous follow up "150325_" email and responses C3 and C5."

4. The Board requested additional information regarding justifications for occupancy level design categories for the Ferry Terminal of level 2 and level 3, as opposed to level 4 for essential facilities, which the Terminal could become in some earthquake emergency scenarios.

   AR 4: The applicants state, "per the EIR, the ferry terminal is considered a non-essential structure which does not fit into Risk Categories I, III, or IV and is therefore Risk Category II per CBC Table 1604.5 and will be designed to satisfy all code minimum requirements as such. Recognizing that the facility is one of the few means of transit from Treasure Island, an additional voluntary operational performance condition will be incorporated into the design. This

voluntary operational performance condition will provide for continued operations following a rational design event. Performance for this voluntary operational event will be determined based on the ASCE 61-14, Seismic Design of Piers and Wharves. The attachment shows the design criteria revised accordingly. This criteria was presented to the Port of SF who will be reviewing the design and they indicated this an acceptable criteria."

BR4 (a): The ECRB requested information regarding justifications for occupancy level design levels 2 and 3 for the Ferry Terminal, as opposed to level 4 for essential facilities, that the Terminal could become in some earthquake emergency scenarios. Ferry motions and response to waves and winds can exceed thresholds considered safe for operations- too rough for passenger safety. What percentage of the time is operational vessel criteria expected to be exceeded at the TI terminal, and potentially interfere with post-disaster access?

5. The Board requested further information concerning the analyses conducted to estimate the lateral movement expected of the DSM barrier and associated retaining wall during design earthquake ground motions from the nearby Hayward and San Andreas faults. Estimates depicting the lateral extent and volume of likely liquefaction induced failure in and along the margin of the Bay are needed, as well as information on scenarios that might be undertaken to repair failure following a damaging earthquake.

AR 5: "The applicant performed deformation analysis at the DSM buttresses using a general limited equilibrium (GLE) analyses and the guidance of the National Cooperative Highway Research Program, Report 611; Seismic Analysis and Design of Retaining Walls, Buried Structures, Slopes, and Embankments (NCHRP, 2008). "The output of the analysis shows a factor of safety of 1.0 with a pseudo-static seismic coefficient of 0.15g. Based on a MCE PGAm of 0.46g at the site, and using the NCHRP 611, the horizontal deformation expected behind the DSM wall is approximately 1-foot (Figure 5). For estimates of lateral extent of lateral spread failure see response to comment 3 (Figure 2-1 and Figure 2-2). Long term property assessments will fund adaptive management for sea level rise and as-needed geotechnical stabilization repairs. The figures are referred to in the attached documentation."

BR 5 (a): The ECRB requested further information concerning the analyses conducted to estimate the lateral movement expected of the DSM barrier and associated retaining wall during design earthquake ground motions from the nearby Hayward and San Andreas faults. Estimates depicting the lateral extent and volume of likely liquefaction induced failure in and along the margin of the Bay are needed, as well as information on scenarios that might be undertaken to repair failure following a damaging earthquake.

6. The significant wave action anticipated from frequent westerly winds in San Francisco Bay and those generated by large container shipping vessels and ferries implies that a third breakwater protecting the entrance of the terminal harbor will be needed. Design plans for such a break water together with the amount of fill implied by each the breakwaters are requested.

   AR 6: The applicants stated that, "a third breakwater alternative was discussed in the attached App D on the submittal with the quantities shown. The 2-breakwater arrangement will reduce waves to acceptable operational levels. The wave climate at TI due to ship wakes is similar to the downtown SF ferry terminals, which operate satisfactorily without a detached breakwater."

   BR 6 (a): The third breakwater option is provided in EIR materials (Appendix D, Chapter 5.7) provided on disc by the applicants' representative prior to the ECRB review of the SubPhase 1A project. These materials compiled by MN analyze three alternatives for the breakwaters. Alternative 1 is two breakwaters of equal length, Alternative 2 is three breakwaters, Alternative 3 is two breakwaters with the northern breakwater inclined and being considerably longer than the southern breakwater. These results seem to suggest that either Alternative 2 or Alternative 3 is acceptable, but that Alternative 1 is not. To expedite review of the project at a later design stage, a summary indicating the reasons for the chosen breakwater alternative, the chosen construction procedure, its design, and its corresponding volume of fill estimates would be helpful.

7. The Board recommended a thorough study of the influence of the ferry terminal breakwaters on shoreline erosion and sand build up in and along the margins of TI over the intended lifetime of the breakwaters and requested a summary of the results of the study.

   AR 7: MN Submittal to ECRB, Appendix D, chapter 5.7 provides this information.

   BR 7 (a): The MN EIR report, Appendix D, chapter 5.7 provides ebb and flow current models for each of the breakwater alternatives. Corresponding models of sediment or sand build up, if they have not been developed, are probably best developed based on observations after construction, unless sediment build up and dredging requirements can be reduced by choice of breakwater alternative.

   AR 7 (a): The applicants have stated that, although the issue was addressed by Moffat & Nichols at the prior ECRB meeting, they will reiterate this at the May 28, 2105 review.

8. The Causeway is considered a critical lifeline for the island in case of an earthquake emergency. Completion of the causeway's general design and submittal of the plans for ECRB review is requested.

   AR 8: The applicants state that, "TICD and TIDA may want to provide to the Board the causeway's geotechnical mitigation plans for acursory review. It is customary to have reviewed the subject documents reviewed by SFDPW, SFDBI, and/or SF Port."

   BR 8 (a): Considering that the plans requested in items 8 and 9 are for some of the major components of the SubPhase 1A project and that these components are within the 100 foot shoreline jurisdiction of the BCDC, what conservatism is being used in designing the Causeway considering this is an essential pathway that needs to remain useable during and after a strong motion event. If the utilities and access are deemed essential (like Risk Level IV), how would such risk level translate to design for the Causeway? Is there a bigger event considered for the Causeway? Please submit plans and outcomes of reviews by other SF Bay agencies.

   AR 8 (a): The applicants state that, "the Causeway is essential to the circulation off the island which is why the design of the improvements is so robust. We will explain the criteria in May in the context of the safety of fills relative to the public access improvements. We will not go into the actual design…." "The criteria was presented at the ECRB hearing by ENGEO, but it will be re-presented in May."

9. As the design stages for the DSM, Causeway, Dikes, breakwaters, and shoreline retaining structures approach later stages of completion, the applicants is encouraged to provide updated plans for review, including additional geotechnical details.

   AR 9: "TICD and TIDA may want to provide to the Board the updated geotechnical mitigation plans for acursory. It is customary to have reviewed the subject documents reviewed by SFDPW, SFDBI, and SF Port."

   BR 9 (a): See response included in item 8 above.

   AR 9 (a): The applicants state, "Yes, site specific analysis will be conducted for future phases. We propose that the ECRB recommend to staff that this be done but going back to ECRB should not be a requirement and should be left up to staff based on an assessment of risks/safety of fills to the public access components within the jurisdictional band."

10. Additional information is requested on the capacity of plans for Subphase 1A of the project to adapt dikes after 16 inches of SLR for higher levels anticipated in 2100. Information is needed documenting a conceptually feasible adaptation strategy for higher sea levels, consistent with projections for the year 2100, which are 36 inches (mid-range "projection") and 66 inches (high) per NRC 2012, Ocean Protection Council

(OPC) 2013. If there was a higher perimeter barrier, would there be enough real estate and adequate slope stability? If overtopping were allowed into the undeveloped shoreline band during extreme events, where would the water go or how would it be contained? Additional information is needed on storm water removal system capacities during overtopping and potential liquefaction induced dike failures.

AR 10: "Copies of the infrastructure plan and open space plan, with this information, will be provided as requested."

BR 10 (a): The Board requested additional information on the capacity of plans for Subphase 1A of the project to adapt dikes after 16 inches of SLR for higher levels anticipated in 2100. Information was needed documenting a conceptually feasible adaptation strategy for higher sea levels, consistent with projections for the year 2100, which are 36 inches (mid-range "projection") and 66 inches (high) per NRC 2012, Ocean Protection Council (OPC) 2013. If there was a higher perimeter barrier, would there be enough real estate and adequate slope stability? If overtopping were allowed into the undeveloped shoreline band during extreme events, where would the water go or how would it be contained? Additional information is needed on storm water removal system capacities during overtopping and potential liquefaction induced dike failures.

AR 10 (a): The applicants state, "regarding overtopping on ferry floats, there will be no overtopping in the span of 50 years. The life cycle of these structures is 50+ years and further improvements are expected to occur after that point."

11. Information is needed on compliance of the various aspects of the Subphase 1A project with special flood hazard zones, the new NFIP/FEMA maps, and requirements of the City of San Francisco. An explanation of the project's benefits in terms of potentially reducing deformation and lateral movement of existing material into the Bay during earthquake loading could be useful. An explanation of the potential impacts on the Bay with and without the project could also be interest.

AR 11: The applicants state, "liquefaction induced shoreline deformation outboard of the of perimeter improvement zone for various levels of Peak Ground Acceleration (PGA) is summarized in the[following] table":

PGA up to 0.16g Loma Prieta Event (Feet)	PGA 0.16g to 0.25g Lome Prieta to 72-years Event (Feet)	PGA 0.25g to 0.46g 72-years Event to MCE (Feet)
Up to ½	½ to 2	2 to 7

"To demonstrate potential slumping of shoreline into the bay during the Maximum Considered Earthquake (MCE), we compared the estimated deformations and failure modes for the existing ground conditions, and for the proposed improved ground conditions. Existing Ground Conditions: With the existing, un-improved, ground conditions, during the MCE, the sand fill and shoals below the groundwater level will liquefy and lateral spreading of the ground will occur toward the free face, island's perimeter slopes. During and immediately after seismic ground shaking, it is likely that the following effects will occur on the island: Ground fissures will open as far as several hundred feet inland from the shore. The upper fill layers will fragment into blocks separated by fissures and the blocks will move toward the island margin, with progressively larger displacements closer to the shore. The underlying liquefied sand will vent vertically through the cracks forming sand boils, and near the perimeter flow will occur into the Bay. The venting of sand and lateral block movement will result in large vertical and lateral deformation of the Ground Proposed Improved Ground Conditions: In general, the proposed shoreline ground improvement zone (edge buttress) will be inboard of the perimeter rock dike with a setback approximately 10 to 12 feet from the shoreline top-of-slope. We have estimated that the ground between the edge buttress and the top of slope will experience two to seven feet of lateral deformation during the MCE event, while ground deformations inboard from the edge buttress will be limited. Based on Zhang, 2004, we estimated lateral displacements at the shoreline of 16 feet for the MCE. A simplified illustration of the estimated shoreline displacements for the proposed improved ground conditions and existing ground conditions is shown on Figure 2-1. A representation of expected island perimeter performance under the proposed improved ground conditions and the existing ground conditions is shown on Figure 2-2, see attachments."

BR 11 (a): the Board requested information needed on compliance of the various aspects of the Subphase 1A project with special flood hazard zones, the new NFIP/FEMA maps, and requirements of the City of San Francisco. An explanation of the project project's benefits in terms of potentially reducing deformation and lateral movement of existing material into the Bay during earthquake loading could be useful. An explanation of the potential impacts on the Bay with and without the project could also be interest.

12. To comply with *San Francisco Bay Plan* Safety of Fills Policy 3, a plan is needed for installation and maintenance of seismic instrumentation to record the response of critical structures associated with project SubPhase1 A. In this regard, the ECRB encourages the applicants to develop a plan in conjunction with the Strong-Motion Instrumentation Program of the California Geological Survey to record the ground response at the Ferry Building, the response of the DSM barrier structure, the ground motion at the base of the causeway, and the strains and the relative motions of the dikes and retaining structures associated with settlement and lateral movement. The applicants is encouraged to consider the installation of two arrays of borehole sensors from the surface to the base of the DSM barrier at the time of installation of the DSM trench to minimize costs of installation.

AR 12: *The applicants responded, "as shown on the attached Figure 4-1, we propose to install one accelerometer on the DSM buttress at the new ferry terminal location. In addition, we propose to conduct a post-construction LiDAR survey of the island's shoreline within the 100 foot band of BCDC jurisdiction. This as-built LiDAR survey will provide a topographic baseline for future post-earthquake deformation surveys."*

BR 12 (a): To comply with *San Francisco Bay Plan* Safety of Fills Policy 3, a plan for installation and long term maintenance of strong motion instrumentation installed on critical components of the project. Considering the cost of the TID project and the relevance of the strong motion recordings to future development of TI, development of a cooperative instrument installation and maintenance program between the TIDA and the California Strong-Motion Instrumentation Program (CSMIP) of the California Geological Survey, could be of considerable benefit to the TIDA. On past projects such as the East Span of the San Francisco Bay Bridge and BART, CSMIP has helped the applicants develop plans for preferred locations for the instruments, installed the instruments and assumed long term maintenance responsibilities, provided the applicants provide the costs for initial instrument purchase. The costs for the instruments are small compared to the long term maintenance costs and minor compared to the information that can be gained to reduce costs of future projects on TI. In addition, modern instrumentation can provide the recordings in real time for display to the public and a variety of early warning applications to promote public safety. Hence, the applicants' representative is strongly encourage to develop a cooperative instrumentation installation and maintenance program between the TIDA and CSMIP for compliance with Safety of Fills Policy 3, as suggested by the ECRB in Item12.

AR 12 (a): *The applicants state that "there is currently an active [instrument] on TI. We will take it under advisement of adding additional instruments."*

Treasure Island Project Elements (Subphase 1A, 1B, 1C and 1E). The overall project has an estimated life expectancy of approximately 80 years or until year 2100, except for the marine structures.

1. **Ferry Terminal**. A proposed ferry terminal would be located at the southwest corner of TI. A new ferry quay and terminal would be constructed to provide service to downtown San Francisco, with a life expectancy of the structure components proposed in the Bay of 40 years. The terminal is proposed to include a shore structure-shelter, two breakwaters and a pier/gangway/float structure.
2. **Shoreline Protection.** The existing rock slope shoreline protection along the perimeter of the Treasure Island would be augmented with additional rock for elevation. Rock would be added on the berm crest to prevent excessive wave overtopping. A setback would be provided to allow rock to be added in the future to raise the elevation of the revetment if needed to address higher sea level. Therefore, an allowance of 16 inches of

sea level rise would be built into the initial construction, and the design would be adaptable to higher levels of sea level rise by leaving a significant development setback such that improvements can be made. Specifically, the revetment would be initially raised to provide protection for up to 16 inches of sea level rise. Because 300 feet of open space would lie between the revetment and urban infrastructure and development on the west side of the island, land is available to raise the revetment if needed to address additional sea level rise.

3. **Geotechnical Improvements**. The project would have significant levels of ground improvement consisting of ground densification on the shore side of the rock perimeter in order to address geotechnical issues.
4. **Development Area Grading (not within the purview of BCDC).** All buildings, entrances to subterranean parking and street elevations would be three feet higher than the present Base Flood Elevation (BFE) to address sea level rise. The finished floor elevations (FFE) of all buildings would have an extra half-a-foot of freeboard.
5. **Stormwater Management.** The gravity-drained storm drain system would be constructed with an initial SLR allowance of 16 inches, and would be adaptable to higher levels of SLR with minimal intervention by installing pumps. This strategy would avoid installing pumps and other appurtenances at the present time, when they are not needed, while still ensuring that an adaptation strategy and a funding mechanism exists for future storm drain management actions. The gravity-drained system would function until at least 2037 (and most likely until 2060), beyond which storm drain pumps would likely need to be installed.

Law and Policy Considerations. The *McAteer-Petris Act*, the law that created the Commission, allows the Commission to approve fill only if it meets certain specific criteria, including that the fill be constructed "in accordance with sound safety standards which will afford reasonable protection to persons and property against the hazards of unstable geologic or soil conditions or of flood or storm waters" (Section 66605(e)) and that that the fill should be the “minimum necessary to achieve the purpose of the fill” (Section 66605(c)).

Within the Commission’s 100-foot shoreline band, the Commission can only deny a project if it fails to provide the “maximum feasible public access consistent with the project” (Section 66632.4).

Additionally, in order to carry out its responsibility, the Commission adopted policies in the San Francisco Bay Plan regarding the safety of fills, shoreline protection and climate change, which include the following:

San Francisco Bay Plan Policies on the Safety of Fills

1. Policy No. 1 states, in part, that “the Commission has appointed and empowered the ECRB to:

   (a) …review safety criteria for Bay fills and structures thereon; and

   (b) review all except minor projects for the adequacy of their specific safety provisions, and make recommendations concerning these provisions….”

2. Policy No. 2 states that, "even if the Bay Plan indicates that a fill may be permissible, no fill or building should be constructed if hazards cannot be overcome adequately for the intended use in accordance with the criteria prescribed by the ECRB."
3. Policy No. 3 states that, "to provide vitally-needed information on the effects of earthquakes on all kinds of soils, installation of strong-motion seismographs should be required on all future major land fills. In addition, the Commission encourages installation of strong-motion seismographs in other developments on problem soils, and in other areas recommended by the U. S. Geological Survey, for purposes of data comparison and evaluation. "
4. Policy No. 4 states that "[a]dequate measures should be provided to prevent damage from sea level rise and storm activity that may occur on fill or near the shoreline over the expected life of a project. The Commission may approve fill that is needed to provide flood protection for existing projects and uses. New projects on fill or near the shoreline should either be:

    - set back from the edge of the shore so that the project will not be subject to dynamic wave energy;
    - be built so the bottom floor level of structures will be above a 100-year flood elevation that takes future sea level rise into account for the expected life of the project;
    - be specifically designed to tolerate periodic flooding; or
    - employ other effective means of addressing the impacts of future SLR and storm activity."

San Francisco Bay Plan on Shoreline Protection

1. Policy No. 1 states that "[n]ew shoreline protection projects and the maintenance or reconstruction of existing projects and uses should be authorized if:

    (a) the project is necessary to provide flood or erosion protection for:

        (i) existing development, use or infrastructure, or

        (ii) proposed development, use or infrastructure that is consistent with other Bay Plan policies;

    (b) the type of the protective structure is appropriate for the project site, the uses to be protected, and the erosion and flooding conditions at the site;

    (c) the project is properly engineered to provide erosion control and flood protection for the expected life of the project based on a 100-year flood event that takes future sea level rise into account;

    (d) the project is properly designed and constructed to prevent significant impediments to physical and visual public access; and

(e) the protection is integrated with current or planned adjacent shoreline protection measures. Professionals knowledgeable of the Commission's concerns, such as civil engineers experienced in coastal processes, should participate in the design."

San Francisco Bay Plan Policies on Climate Change

1. Policy No. 1 states that "[w]hen planning shoreline areas or designing larger shoreline projects, a risk assessment should be prepared by a qualified engineer and should be based on the estimated 100-year flood elevation that takes into account the best estimates of future sea level rise and current flood protection and planned flood protection that will be funded and constructed when needed to provide protection for the proposed project or shoreline area. A range of sea level rise projections for mid-century and end of century based on the best scientific data available should be used in the risk assessment. Inundation maps used for the risk assessment should be prepared under the direction of a qualified engineer. The risk assessment should identify all types of potential flooding, degrees of uncertainty, consequences of defense failure, and risks to existing habitat from proposed flood protection devices."
2. Policy No. 2 states, in part, that "[t]o protect public safety and ecosystem services, within areas that a risk assessment determines are vulnerable to future shoreline flooding that threatens public safety, all projects should be designed to be resilient to a mid-century sea level rise projection. If it is likely the project will remain in place longer than mid-century, an adaptive management plan should be developed to address the long-term impacts that will arise based on a risk assessment using the best available science-based projection for sea level rise at the end of the century."
3. Policy No. 5 states that "Wherever feasible and appropriate, effective, innovative sea level rise adaptation approaches should be encouraged."

ECRB Advisory Role. BCDC seeks the Board's advice with respect to the proposed project in light of BCDC's law and policies:

1. **Seismic, Structural and Geotechnical Concerns**

   a. **Ferry Terminal**. According to the information, the piles to be driven within approximately 10 feet of the toe of the rock dike and within the soft young bay deposits will be subjected to kinematic loads. The rock dike may displace horizontally from approximately 2 to 10 feet towards the Bay while there's a potential of about 3 feet of horizontal deformation of the soft bay deposits outboard of the island.

   Has the impact of earthquake-induced liquefaction and lateral failures on the structure been properly addressed in the proposed criteria?

   According to the information, the terminal will be designed to satisfy all code requirements fitting to Risk Category II per CBC Table 1604.5 for non-essential facilities. An additional voluntary operations performance condition will be incorporated in to the design for continued operations following a rational event as determined by ASCE 61-14, Seismic Design of Piers and Wharves.

Is this occupancy level design category adequate to respond to earthquake emergency scenarios?

The document entitled, "*Treasure Island Redevelopment Project, Ferry Terminal Basis of Design*," is enclosed in the digital material for any supporting and reference information.

b. Geotechnical Hazards. According to the information, the horizontal deformation expected behind the DSM wall is approximately 1 foot. Further, liquefaction-induced failure, in and along the margin of the Bay, will be dramatically reduced following project development. The majority of the potential failure locations could be restored to their pre-earthquake serviceability by moving the displace materials back to their original location with minimal amount of new import materials.

   In addition, the Causeway embankment slopes are subject to failure during strong earthquake ground shaking, and the roadway surface at the top of the Causeway is subject to large horizontal and vertical deformations in their current conditions. As a result, the project proponent proposed significant ground improvement to mitigate such current conditions. The project's team provided descriptions of the design methods and analysis to evaluate likely failure modes and confirm its deformation assumptions.

   Are the measures considered sufficient to preclude potential failures of the shoreline public access, in light of the Causeway being considered a critical lifeline for the island?

c. Specific Seismic Response Spectra. Existing project site conditions that will not be altered with rigid ground improvement techniques will be developed with seismic response spectra. However, the project team states that specific response spectra for locations of ground improvement is not representative of actual post-construction site response, and, therefore, should be excluded of Site Class F categorization.

   Is this an appropriate approach towards the overall site's safety evaluation?

d. *Contingency provisions. Has the applicants' additional information addressed all of the Board's concerns regarding the overall safety criteria of the project as raised in the original meeting of January 22, 2015?*

e. Policy No. 3 of the Safety of Fills requires the development of a seismic instrumentation plan appropriate for each major fill project.

   Although the applicants have proposed the installation of monitoring equipment (up to two borehole seismic sensor arrays within the proposed DSM shoreline and/or Causeway stabilization structures) in general conformance with CSMIP standards, previous project proponents have worked directly with CSMIP staff for the planning and suitability of the most effective program for each project. BCDC has already provided samples of other instrumentation plan agreements with CSMIP to the applicants. The permit would include conditions to meet such requirement to be provided to the ECRB for review and approval.

2. **Sea Level Rise and Flooding Concerns**. The project proponent has provided a sea level rise risk assessment and adaptive management plan as required by BCDC's Climate Change policies. The information provides vulnerability analysis, sea level rise assessment and project specific sea level rise projections, and project design features that include adaptation measures. Please note that only areas within 100 feet of the shoreline are within BCDC's and ECRB's purview.

   According to the information, the project would adopt 36 inches of SLR allowance for development features with low adaptive capacity such as the building pads and major streets. The grades of the new development areas would be raised to accommodate SLR over a 70-year horizon. This is so that these assets would be protected well into the future.

   A similar 36-inch level of protection for the project's perimeter would be adopted for the shoreline, except that the construction would be implemented in two phases, 16 inches of SLR allowance at the end of the initial project construction until year 2050 and possibly beyond, and an additional 20 inches of SLR allowance when SLR rates approach the 16-inch threshold. This is so because these development features (parks and open space) envisioned along the perimeter have a high adaptive capacity and high resilience.

   Are the flood risk assessment and the adaption measures adequate and conservative for the life of the project?

Enclosed Material

1. Agenda for May 28, 2015 meeting.
2. Draft minutes of February 26, 2015 meeting regarding the Brooklyn Basin and MOTCO projects.
3. Technical Memo No. 3/Supplemental Basis of Design-Response to ECRB Comments, May 13, 2015.
4. Digital CD: References, including TI Risk Assessment, drawings, Geotechnical Report of Subphases 1B, 1C and 1E, and Technical Memo No. 3/Supplemental Basis of Design-Response to ECRB Comments, May 13, 2015.